International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Effect of Friction Dampers on RC Structures Subjected to Earthquake

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How to cite this paper: Akshay R | B. S. Suresh Chandra "Effect of Friction Dampers on RC Structures Subjected to Earthquake" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.2616-2618, **https://doi.org/10.31142/ijtsrd28017**

IJTSRD28017

ABSTRACT

Among all the natural disasters such as flood, earthquake, drought, hurricanes the least understood and the most destructive one is earthquake. Since, they cause many of injuries and economical losses leaving behind a series of signs of panic. Necessity to implement seismic codes in building design. For this a better method of analysis such as static analysis, dynamic analysis and time history analysis has to be adopted for performing the structures seismic risk assessment. This dissertation work is concerned with the "Studies on Effect of Friction Dampers on the Seismic Performance of RC(G+15) Storey Buildings" According to IS 1893 (part 1): 2002 codal provisions the structures are analyzed by Equivalent Static method & Time History method. The modeling and analysis is done with ETAB SOFTWARE and the results obtained are seismic parameters such as Time period, Base shear, Lateral displacement and Inter storey drift, storey stiffness, storey accelaration are tabulated and then comparative study of structures with and without Friction dampers has been done.

KEYWORDS: *Friction dampers; Base shear, Lateral displacement Storey drift, storey shear, storey accelaraation, slip load, and storey stiffness*

1. INTRODUCTION

Need for Earthquake Resistant Structure

Severe ground shaking induces lateral inertial forces on buildings, causing them to sway back and forth with amplitude proportional to the energy fed in.

If a major portion of this energy can be consumed during building motion, the seismic response can be considerably improved. The manner in which this energy is consumed in the structure determines the level of damage.

The use of bracing systems equipped with dissipative devices is relatively new technique for the earthquake protection of buildings that has been considered in several recent experimental and theoretical studies. In particular, the friction damping bracing system involving the device proposed by Pall and Marsh (1982) has been carefully analyzed, since its simplicity of construction and high dissipative capacity encourages application in practice. At present, the existing studies offer sufficiently detailed information about the protection level, expressed in terms of energy absorption or reduction of maximum horizontal displacement.

Friction dampers dissipate specifically kinetic energy through sliding of plate /surfaces. It can be equivalent to 30% critical damping ratio. Structural damage results in a reduction in structure stiffness and in the modal parameters of building structures. To improve seismic response friction dampers is provided as X-brace. Energy dissipation capacity depends upon its damping coefficient & non-linearity is defined by the damping exponent. Results show that using friction dampers to building can effectively reduce the building responses by selecting optimum damping coefficient i.e. when the building is connected to the friction dampers, can control both displacements and accelerations of the building.

2. LITERATURE REVIEW

S. S. Sanghai, et.al, This paper dealt with the use of friction damper as a passive dispel device. To achieve the objective, six storey and ten storey L-shaped structures has been modeled with five different damper location formats in SAP2000 subjected to El Centro and Utterkashi earthquake records. Non-Linear Modal Time Historey Method has been used for the analysis and base shear, joint displacement, member forces and hysteresis energy has been compared to find most optimal damper location format. The results displayed that the damper placement affects significantly the structural response. It was also found that many dampers don't give better results.

Milin N. Rajkotia, et.al, This paper deal with structures with and without friction damper subjected seismic loading with unsymmetrical plan. In this study a five storey frame structure with irregularity has been examined and the modeling is supported by software SAP2000. Different limitations such as base shear, axial force, shear force, torsional moment, bending moment, fundamental time period, energy dissipation of bare frame and friction-damped frame have been studied. The study of different parameters has been done for the design of the friction damper. It was found that the slip load of the friction damper is the principle restriction and the optimum selection of which would reduce the response of the structure. As per the results, friction damped frame proved to be more effective

3. OBJECTIVES

Aim and Objectives of the Present Study

1. The main aim of the research program is to analysis the building with friction dampers to that of the bare frame subjected to Non-linear time history method.
2. To study the effect of friction dampers placement along width and height of building
3. To study the effect of relative stiffness on the behaviour of damped frames.
4. To study the comparision between building with and without friction dampers by non-linear time history method.
5. To investigate the contribution of friction dampers to lateral strength and lateral stiffness of the buildings.
6. To quantify the structural behaviour due to presence of friction dampers.
7. Draw the seismic parameters such as displacement, story acceleration, story drift, story force, base shear in terms of graphs.
8. To know % energy dissipated under seismic force.

4. MODELING AND ANALYSIS

Time-history analysis

The analysis of models (bare frame, with dampers) Nonlinear Time-History with Bhuj records adapted. Time-history analysis is a step-by-step process to a specified loading that vary with time. Linear or nonlinear analyzes can be done.

Model Description

For the study purpose a 15 story building model has been considered,

1. Number of stories = G+15
2. C/C dist between columns in X- dir = 4m
3. C/C dist between columns in Y- dir = 5m
4. Foundation level to ground level = 3m
5. Floor to floor height = 3m
6. Wall thickness = 230 mm
7. Live load on all floors = 3 kN/m²
8. Live load on all roofs = 1.5 kN/m²
9. Floor Finishes = 1 kN/m²
10. Material = M25; M30 and Fe415; e500
11. Depth of slab = 150 mm

Materials

ISA 150x150x10 equal angle section is brace in which damper is been added

1. Mass of damped brace, M = 117.192 kg
2. Weight of damped brace, W = 1.1496
3. Direction U1 – Non – linear Property
4. Post yield stiffness ratio = 0.0001
5. Effective stiffness of brace along 5m span, Ke = 112957.2 kN/m
6. Effective stiffness of brace along 4m span, Ke = 135023.2 kN/m
7. Yielding exponent = 10
8. Yield strength/Slip load of friction damper = 250 kN

5. RESULTS AND DISCUSSION

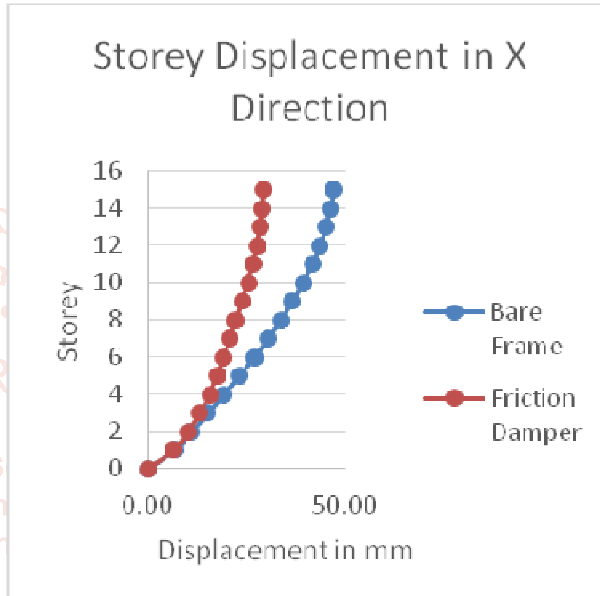
It deals with results and discussion of bare frame structure and structure with Friction Damper

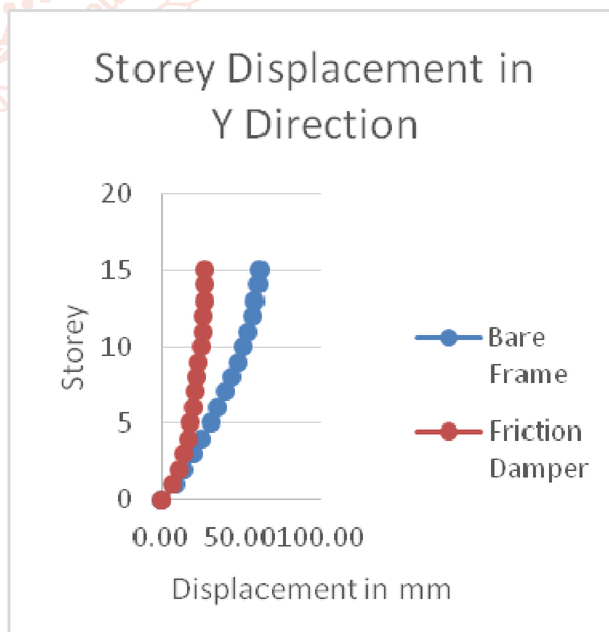
Discussions are made based on following parameters

1. Storey Displacement
2. Storey drift
3. Storey acceleration
4. Storey Stiffness
5. Base Shear
6. 5.2 Storey Displacement
7. The floor level versus displacement graph is been plotted for both models in X and Y direction.

STOREY DISPLACEMENT

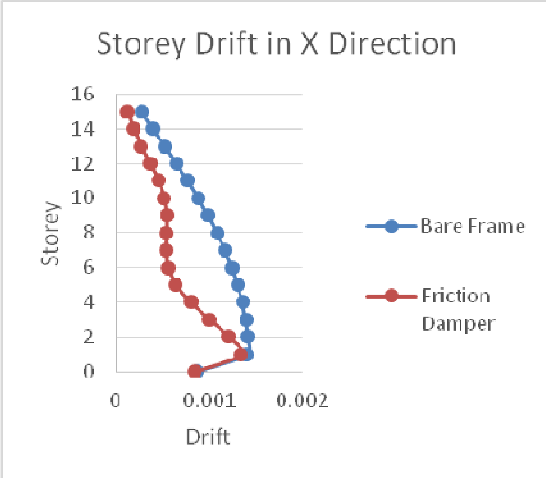
It is the important factor, when the structure is affected by seismic forces and wind forces. it mainly depends on the height of the structure and tall structures are more flexible for lateral loads.

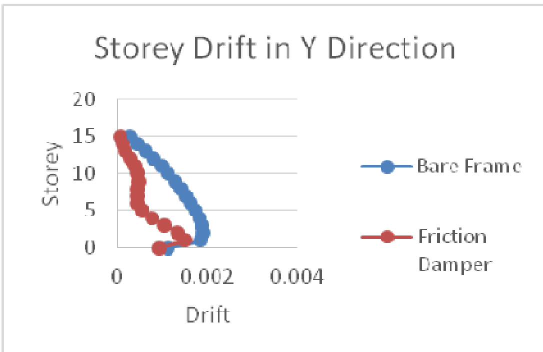




STOREY DRIFT

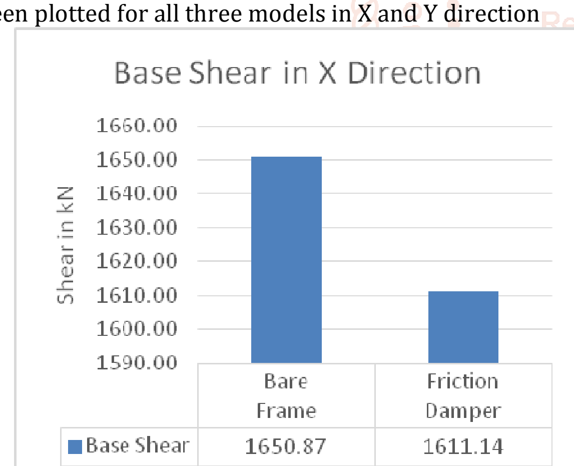
The floor level versus drift graph is been plotted for both models in X and Y direction.





Base Shear

The Shear force at the base of the structure so obtained is been plotted for all three models in X and Y direction



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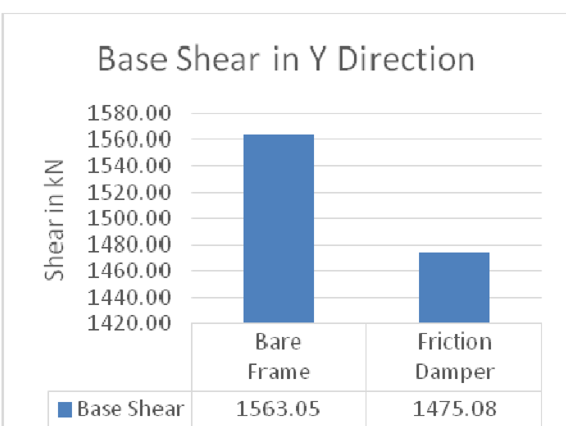

6. CONCLUSION

In this study the focus is made on the study of seismic effect on RC building. The performance of building is studied in terms of time period, base shear, lateral displacements, storey drifts with linear or non linear analysis with and without friction dampers of (G+15) storey building models. Analysis is carried by equivalent static and time history method.

We can conclude from analysis ad result obtained from present study.

A. Frictions dampers provided on periphery reduces lateral displacement due to earthquake force.
B. Provision of friction dampers to building reduces storey drift and helps to increase shear resistance
C. The effectiveness of friction dampers helps in controlling lateral displacement, storey drift due to earthquake force is observed in time history analysis method.
D. Friction dampers provision helps to decrease storey shear linearly with respect to height of the storey increases compared to bare frame
E. From above result and discussion it is concluded that corner damping for all stories is most effective placement of friction damper compare to bare frame.

ACKNOWLEDGEMENTS

I am very much thankful to my guide **B S SURESHCHANDRA** for their guidance and also very much thankful to Structural Engineering Department, Faculty of **Dr. AIT** for giving such a good facilities and platform to complete the dissertation work and also my dear friends who have support me to complete this work.

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